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ABSTRACT

This module contains information on unibody construction and control points for structural measurements to perform repairs on the bodies of unitized vehicles. The module covers the fundamental aspects related to the measuring and fixturing techniques used to analyze collision damage before and during repair operations. Designed for individualized instruction, the module consists of a teacher guide, a student guide, a student evaluation, a 35mm slide presentation, and an audiocassette. The instructor guide contains an introduction, performance objectives, script for a slide presentation, suggested instructional methods, suggested resources, and an answer key for the student evaluation. The student guide contains performance objectives, an introduction, procedures for using the module, and an information sheet on repairing cars with unitized construction. (KC)

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INSTRUCTOR'S GUIDE

PROGRAM: Auto Body **UNIT TITLE:** Unitized Vehicles

MODULE TITLE: Measuring and Fixturing Techniques **MODULE NO.** AB-83-230

INTRODUCTION: This module will cover the fundamental aspects related to the measuring and fixturing techniques used to analyze collision damage before and during repair techniques.

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PERFORMANCE OBJECTIVES:

After completing this module you should be able to:

1. Understand unibody construction and identify control points for structural measurement.
2. Perform suspension quick-checks to locate components and assess their condition.
3. Determine the terms "datum line," "datum distance," and "center line."
4. Describe the three types of measuring systems commonly used.

Learning Groups Designed For:

- X **Adult**
- _____ **Special Needs**
- X **Secondary**
- X **Post Secondary**

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TEACHING/LEARNING RESOURCES:

X Student Packet	____ Videocassette
X Instructor's Guide, Key, and Script	____ Film Loop
X 35mm Slide Presentation	X Audiocassette
____ Filmstrip	

RESOURCE MATERIALS:

a. The New Science of Unibody Repair, Blackhawk Applied Power Inc., 1982.
b. Wheel Alignment Equals Motion Balance, Hunter Engineering Corp., 1977.
c. Front and Rear Suspension Systems, Ford Motor Company, 1977.

INSTRUCTIONAL METHODS SUGGESTED:

This packet is designed for individualized instruction in open entry/open exit programs; however, these materials may be used to supplement traditional instructional methods. Tests may be used for pretesting for advanced placement of students who are already competent in this area. Demonstrations by the instructor are recommended to enhance student learning.

A performance evaluation should be completed by the instructor after the student has completed this module. It is recommended that performance checks be conducted on each measuring system available in the shop.

KEY

STUDENT EVALUATION

MEASURING & FIXTURING TECHNIQUES

1. Explain the structural design of a unibody car.

   THE UNIBODY CAR IS A SELF-SUPPORTING, ALL-WELDED STEEL STRUCTURE OF A SINGLE UNIT DESIGN.

2. Where are control points located on a vehicle?

   ON THE UNDERNEATH STRUCTURAL PANELS OR RAILS OR ASSEMBLY JIG FIXTURE LOCATIONS.

3. What does performance quick checks of jounce and rebound tell us on a vehicle check?

   IF THE STEERING AND SUSPENSION COMPONENTS OR MOUNTING LOCATIONS ARE IN CORRECT ALIGNMENT.

4. What is the average weight of the vehicle of the 1980's. Circle one.

   a. 2000 pounds

   b. 2700 pounds

   c. 3500 pounds

5. What is the primary use of high-strength, high-strength-low-alloy steel?

   IT IS LOCATED IN THE UNIBODY STRUCTURE AT SELECTED LOCATIONS TO HELP PRODUCE A FLEXIBLE, LIGHTWEIGHT UNIT WITH HIGH POUNDS PER SQUARE INCH TENSIL STRENGTH PANELS.

6. How many different measuring systems do we have on the market today? Write a brief description of each of them.

   THREE -
   1. TRAM AND CENTERING GAUGES
   2. UNIVERSAL MEASURING SYSTEMS (MECHANICAL & LASER BEAM)
   3. THE DEDICATED BENCH SYSTEM

7. Unitized bodies must be built to extremely close tolerance, How is this accomplished?

   BY ASSEMBLY ON A JIG FIXTURE

8. Why must the whole car be checked, even though the external damage is limited only to one area?

   THE IMPACT AREA IS PRIMARY DAMAGE; SECONDARY DAMAGE WILL EXTEND BEYOND THE PRIMARY DAMAGE AREA TO ALMOST ANY AREA OF THE CAR. MEASUREMENT OF DAMAGE ON UNIBODY VEHICLES MUST BE STARTED FROM AN UNDAMAGED AREA AND IN REVERSE SEQUENCE OF DAMAGE AS IT IS A SINGLE UNIT DESIGN.

9. How do car manufacturers get by without using thicker materials in some areas where greater strength is needed?

BY USE OF HIGH STRENGTH AND HIGH-STRENGTH-LOW-ALLOY STEEL WITH TENSIL STRENGTH UP TO 3 TIMES THE STRENGTH OF MILD STEEL THAT IS USED IN MOST PANELS.

NOTE: MILD STEEL HAS TENSIL STRENGTH OF 35,000 POUNDS PER SQUARE INCH. BY ADDING 1/10 OF 1% EXOTIC METALS TO A MILD STEEL RECIPE, HIGH STRENGTH STEEL IS PRODUCED WITH TENSIL STRENGTH UP TO 150,000 POUNDS PER SQUARE INCH.

10. List the four critical elements in unibody measuring and repair.

SIDE SWAY, SAG, MASH, AND TWIST DAMAGE

11. Which measuring system also serves as a holding system for accurate replacement of structural parts?

DEDICATED BENCH SYSTEMS

12. Is the control points on all vehicles used as a measuring location point for all three measuring systems?

Circle: (T) or F

13. Is a dedicated bench system practical for measuring a frame and body cars?

NO. THE PRIMARY PURPOSE OF THE DEDICATED BENCH SYSTEM IS FOR UNITIZED CONSTRUCTED VEHICLES. FIXTURES ARE MANUFACTURED FOR THE UNIBODY JIG FIXTURE OR CONTROL POINT LOCATIONS.

14. To establish a datum plain using a bench system, at least how many control points on the vehicle must be located.

NORMALLY 4. WITH THE SAME PRINCIPAL LOCATIONS USED WITH THE TRAM AND CENTERING GAUGES, WHICH ARE:
1. FRONT OF STRUCTURE; 2. BEHIND FRONT WHEEL AT TORQUE BOX;
3. FRONT OF REAR WHEEL AT TORQUE BOX; 4. REAR OF STRUCTURE

15. We have two types of damage that we think of in unitized repair. What are they?

1. PRIMARY

2. SECONDARY OR INDIRECT

16. What type of suspension, by name, is used on the front of unitized construction cars?

MCPHERSON STRUT

17. McPherson Strut towers are located on the underneath of the car at both the front and rear.

Circle: T or (F) THEY ARE LOCATED AT UPPER END OF STRUT UNITS.

18. Does front structure alignment affect front end alignment angles?

    Circle: (T) or F FRONT STRUCTURE ALIGNMENT ALSO DETERMINES CASTER AND CAMBER ALIGNMENT

19. List the sequence in which repairs of collision damage should occur?

    TWIST, MASH, SAG, SIDE SWAY

20. Mash damage affects what measurement?

    LENGTH

21. Sag damage affects what measurement?

    HEIGHT

22. Side sway damage affects what measurement?

    WIDTH

23. Twist damage is present when one corner of the center section of the frame is higher than the adjacent corner.

    Circle: (T) or F

24. Primary damage during a collision is at what location?

    POINT OF IMPACT

25. Indirect damage is always present on any extensive collision damaged vehicle.

    Circle: (T) or F

AB-83-230 MEASURING & FIXTURE TECHNIQUES USED ON COLLISION-DAMAGED UNIBODY VEHICLES

1. A presentation of The Media Center, State Fair Community College, Sedalia, Missouri.

2. AB-83-230 MEASURING AND FIXTURE TECHNIQUES USED ON COLLISION-DAMAGED UNIBODY VEHICLES.

3. In this module you will become familiar with unibody construction and the control points for structural measurement.

4. After completing this module you should be able to: (1) Understand unibody construction and identify control points for structural measurement.

5. (2) Perform suspension quick checks to locate damaged components and assess their condition.

6. (3) Describe the terms "datum line," "datum distance," and "center line."

7. (4) Describe three types of measuring systems commonly used.

8. The collision repair industry will be particularly affected as changes in auto body construction call for new measuring and repair techniques.

9. Currently, minimum tolerances of 3 millimeter or approximately one-eighth inch are required on body alignment.

10. These changes have occured rapidly due to the need for fuel economy, emission control, and improved safety standards.

11. Industry changes to transverse engines, front wheel drive,

12. as well as MacPherson-type strut suspension, and rack and pinion steering require collision damage repair techniques which are different from those used to rep-ir models of the past.

13. Therefore, measuring techniques to determine the location and extent of damage are also changing.

14. Three measurements should be performed, one before, one during, and one after collision damage repair: (1) Before repair to register the location and extent of the damage. (2) During repair to determine whether repair work is being performed in proper sequence. (3) After repair to assure return to factory specifications.

15. It may become necessary to remove some suspension or power train components in order to make accurate measurements. Some points are not accessible to measurement when assembled.

16. There are seven critical control points on the steering and suspension of a unitized vehicle that must be measured accurately to insure proper repair.

17. Extensive surveys in the United States show that most damage occurs on the front end of a vehicle body. In order to determine the damage, you must look at the typical damage sequence which is the effect of a collision from point of impact throughout the vehicle.

18. When you measure for the damage correctly, you must assess the total vehicle in the reverse sequence of the collision. Thus, you determine the measureable damage from an undamaged portion of a vehicle.

19. Most owner complaints about repaired unibody vehicles are the driving and handling ability. As the steering and suspension are frequently secured directly to the self-supporting steel body structure, these components must be measured for bend damage.

20. The equipment needed to make steering and suspension checks include: a set of turning radius plates, toe in scribe, and a camber gauge or pernumeter.

21. Before steering and suspension checks can be made, a reference mark parallel to the tread on each front tire must be established using a scribe tool or other marking device.

22. Four quick steering and suspension checks are required. For the first check, place the scribe point near the reference mark.

23. Load and unload the suspension from the center of the bumper while observing the pointer and reference mark. If no toe-in change is observed when either side is tested, the steering gear, mounting bracket, tie rods, and steering arms are not damaged.

24. If toe-in change is observed when either the right or left side is tested, steering gear or steering arm misalignment is likely. Make this check with the steering gear locked and with the steering gear unlocked to assure that there is no bind on the steering.

25. The second check is made to determine the condition of the steering arm and spindles. Set the wheel straight ahead and place the protractor scales right and left to 0 degree.

26. Turn right wheel inboard or to the left 20 degrees.

27. Note and record the position in degrees of the outboard left wheel on the protractor. Then return the wheels to zero.

28. Repeat this operation on the left wheel of the vehicle, taking the measurement on the right wheel.

29. Readings on each wheel turned outboard or away from the vehicle should be 20-22 degrees. If the reading on each outboard wheel varies more than four degrees, a bent spindle or steering arm is likely.

30. The third check is done to determine the condition of the strut both front and rear. Place the camber gauge to the spindle or the pernumeter to an even surface on the wheels.

31. Swing the wheel inboard or into the vehicle 20 degrees and take the camber reading.

32. Then swing the wheel outboard or away from the vehicle 20 degrees and take the camber reading. If the strut is straight, the readings on the gauges will vary no more than four degrees.

33. Check each wheel and if the strut is bent forward or to the rear, you will see a significant camber change as you rotate the tire assembly through an arc. A 10 degree variance between readings is not uncommon when the strut is bent.

34. Check four is made to determine the condition of the strut inboard and outboard or side-to-side. Load the suspension system, take a camber reading, and record it. Unload the suspension system and repeat the procedure. Be sure that you take both readings from the same place on both wheels.

35. Compare the two readings. They should be equal or vary no more than plus or minus one-half degree. If the strut is bent in or out, the reading will change significantly. Each wheel must be checked for this condition and all checks should be made in the same sequence.

36. A unibody car either damaged or undamaged, can be measured accurately by two basic points of measurement--a "datum line" or a horizontal plane underneath the vehicle, and the "center line," or a vertical plane that always goes through the exact center of the vehicle and serves as a basis for lateral measurements.

37. Lower structural control points or fixture locations form the basis from which all factory assembly is started. In order to measure for collision damage on the unibody vehicle, you must use the factory dimensions or an undamaged vehicle of the same year and model as the standard.

38. The factory dimensions will establish a datum line from which to take reference measurements. The datum line is a straight, horizontal plane underneath a vehicle that is determined by measuring down from the control points or jig fixture locations used during assembly.

39. The steel tape is the one piece of measuring equipment that is used with each of these measuring systems. It is also used for quick dimension and comparison checks. It is accurate from point to point in an unobstructed straight line.

40. Three measuring systems are used to measure collision damage in order to determine the proper sequence for repairing damaged vehicles to restore them to factory specifications. The three systems are: tram and centering gauge; universal measuring; and dedicated fixture.

41. The TRAM GAUGE is a very versatile gauge used for diagonal, length, datum and

42. three-point checks of the wheel base and/or track for both front and rear wheels. It can achieve accuracy to one milimeter and is used in conjunction with the centering gauges.

43. CENTERING GAUGES should be used in sets of four. They can register underbody sag, twist, and side sway damage and can be used with the gauge to thoroughly check the alignment of the underbody structure of a vehicle that is symmetrically designed.

44. Center gauges can be observed for measuring and then be left on the vehicle during pulling operations to determine the approximate amount of springback. A centering gauge consists of a sliding cross bar with adjustable measuring rules or bars at each end. The sighting pin is always centered.

45. A UNIVERSAL GAUGE or one that has a center pin or target that can be adjusted to any off center position can be utilized with the self-centering gauges to measure a non-symmetrically built vehicle. A non-symmetrically-built vehicle is one that is not equal from the center line outward on both sides.

46. The center line of these gauges can be checked by turning the gauge 180 degrees and comparing the center line reading. Adapters such as magnets, wire loops, or "C" clamps may be required on unibody vehicles for mounting centering gauges.

47. Centering gauges are usually placed at the front and rear structure locations of the vehicle, in front of the rear wheels, and behind the front wheels.

48. The vertical arms are set to "datum height" which is the distance from control point to horizontal plane. The datum distance is the distance between control points on the horizontal plane.

49. The adapters for the gauges must be properly installed to produce accurate readings. These gauges and adapters can be used for frame as well as unibody vehicles. They allow for checks from either end of the vehicle and can be monitored at any time before, during, or after repair.

50. The universal measuring system utilizing the mechanical principle can measure the underbody structure of all types of vehicles by using factory specifications. One system has a self-centering bar attached to a bench, with adjustable pointers to control point locations to make diagonal measurement.

51. Another mechanical system has a light-weight base frame with sleeve and rods that can be positioned both lengthwise and crosswise on stationary and movable profiles that are subdivided into millimeters. They are fixed at the point specified by the measurement sheet when lifted or jacked into position.

52. Still another mechanical system has four adjustable fixtures that are positioned at the torque box locations. A transverse bar affixed to a bench is used to measure distortion of the upper strut tower location.

53. A measurement specification sheet is required for each year and model of vehicle.

54. The laser beam is a second type of universal measuring system which uses a laser beam for the measuring instrument. One unit attaches to a bench and uses a prism to deflect laser rays to or through optical targets for measuring purposes.

55. Another type has the laser unit attached to a mounting bracket that slides in and out or pivots up and down on a transverse bar attached to the vehicle.

56. Both of these laser systems measure all forms of measurement deviations between control points as well as measurement of tram, track, and wheel alignment. Laser beam instruments can be left in place during straightening operations to monitor progress of repair, or they can be removed, replaced and calibrated quickly if they hinder pulling operations.

57. Dedicated fixture systems are always set on a bench and use control points or jig fixture locations as attachment points. These are set to factory specifications by the use of towers or fixtures made for a specific make and model of vehicle. These fixtures measure all distortion from the undamaged portion of a vehicle's understructure.

58. The power train and suspension must be removed in order to measure extensive damage to suspension and rack and pinion mounting location. These fixtures are also used to hold undamaged areas during pulling operations. Fixtures are either rented or purchased for each make and model of vehicle.

59. Each measuring system must meet the following demands: (1) Reveal all types of distortions. (2) Provide universal diagnostic measurement.

60. (3) Provide quick set-up, reading, and monitoring. (4) Compliment the straightening operation rather than prevent or complicate it.

61. (5) Allow one-person operation. (6) Provide sturdy fixtures without heavy lifting devices.

62. (7) Measure the entire car. (8) Measure before, during, and after repair.

63. In this module, you should have learned the following:

64. How to identify the seven critical control points of structural measurement;

65. How to perform four suspension quick checks to locate damaged components;

66. Meaning of the terms "datum line," the horizontal plane underneath the vehicle.

67. "datum distance," (pause) the distance between control points on the horizontal plane.

68. and "center line," (pause) the vertical plane through exact center of the vehicle.

69. Three measuring systems which are the tram and centering gauges, universal measuring systems, and dedicated fixture systems.

70. (CREDITS)

71. (DISCLAIMER)

72. (REWIND)

STUDENT GUIDE

PROGRAM: Auto Body **UNIT TITLE:** Unitized Vehicles

MODULE TITLE: Measuring and Fixturing Techniques **MODULE NO.** AB-83-230

PERFORMANCE OBJECTIVES:

After completing this module you should be able to:

1. Understand unibody construction and identify control points for structural measurement.
2. Perform suspension quick-checks to locate components and assess their condition.
3. Determine the terms "datum line," "datum distance," and "center line."
4. Describe the three types of measuring systems commonly used.

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INTRODUCTION

In this module you will become familiar with unibody construction and control points for structural measurements. The automobile industry has made many changes in structural design in the last five years. The new unitized cars of the 1980's will introduce more change in structural design and structural strength by use of high-strength and high-strength-low-alloy steel. Suspension and power trains will also change in order for the industry to build a light weight, fuel-efficient car. Repair techniques for these vehicles will also change. Technicians, who have been in the trade, will have to modify their work habits in order to make proper repairs. One more change that will take place is new measurements taken for estimating and repairing collision damaged vehicles. This module will cover the fundamental aspects related to the measuring and fixturing techniques used to analyze collision damage before and during repair techniques.

PROCEDURES

1. Read the instructions and objectives of this module.
2. Study the information sheets that are a part of this module.
3. Observe and listen to the slide/tape presentation AB-83-230, "Measuring and Fixturing Techniques."
4. Take notes on any additional information supplied during the instructor's presentation.
5. For additional information, you may refer to one or more of the following references.
   a. The New Science of Unibody Repair, Blackhawk Applied Power Inc., 1982.
   b. Wheel Alignment Equals Motion Balance, Hunter Engineering Corp., 1977.
   c. Front and Rear Suspension Systems, Ford Motor Company, 1977.
6. You will be expected to successfully complete a written test and shop performance tests on all measuring systems available in the shop.

INFORMATION SHEET

We will deal primarily with the unitized construction of the third generation or those cars built from 1978 up to 1985 models. With the introduction to the third generation unitized passenger cars, the collision repair industry will need to greatly modify repair procedures. This will introduce new measuring and fixturing techniques used on these vehicles during the time that they are checked for estimating and repair. The changes that will come about will seem quite rapid. For instance, the average car of the 1970's was front motor, rear drive, body frame design; weighed approximately 4500 pounds with a conventional steering and suspension system, and 18 gauge mild steel used in the body construction.

The vehicles of the 1980's will be a full unitized body construction. The average fleet weight will be 2700 pounds with a front motor, front wheel drive, rack and pinion steering. The Macpherson Strut suspensions will be used on the front end and rear end also. This will establish the need for accurate measurements to analyze and repair the collision damaged vehicle. The computer aided design of the unibody structure is more complex with more to bend, break, twist, or pull loose causing misalignment. The unitized constructed car is a self-supporting steel structure body with a reinforced passenger compartment. The front end and the rear end are designed to crumple and bend upon impact of collision forces.

All points must be precise in order for the front suspension to be in alignment as well as the upper structure for the front fenders to align. Misalignment of any of these points will affect the overall alignment of the other control points in this area. The jig fixtures or control points used in the assembly are located on the underside of the vehicle with the exception of the strut towers, some motor mounting and steering mounting locations. The close tolerance or accuracy of these points are also necessary for the upper body structure and cosmetic panels to be properly aligned on it.

DATUM LINE

These control points are the locations that are used when we measure from the datum line. To explain the datum line, it is a level line or a plain on the underneath of the car. When we measure from the control point down to the datum plain or the level line we can measure for a sag or a twist. We can also measure for length, and we can make diagonal measurements from these control points. All factory specifications will always illustrate the control points and they will establish a datum line from which you may operate. The datum line is a fixed reference plane or line underneath the car for all vertical, contour frame, siderail, or other pertinent measurements. These lines or measurements are established using holes, bolts, spring hangers, or other obvious reference points located on the underside of the vehicle.

DATUM DISTANCE

The datum distance is the distance along the datum line between each of the datum measuring points. This is not a point-to-point measurement. The datum distance measurements are valid only when the datum line is established. The measurements must be always made parallel to the datum line. The datum distance can assist you in locating the holes, bolts, or other points from which datum gauges should be hung.

VERTICAL LEVEL OR CENTER LINE

The vertical level or center line of the vehicle is an imaginary line that always goes through the exact center points of the car and acts as a basis for all lateral measurements. These are necessary due to the fact that many cars manufactured today are what we term a symmetrical or nonsymmetrical design. A car being of nonsymmetrical design is one in which measurements from the center line to the right or left will not be equal. In symmetrical built cars, the measurements from the center line to the right and to the left, whether it be from underneath the car or on the top of the car in the motor compartment, will always be of equal distance.

This will make the necessity to use factory specifications or a like model of the same year to take measurements from in order to determine damage if the measurements are to be accurate. It is also necessary to measure from more than one location. A cross or diagonal measurement is also beneficial. More than two measurements on length is also beneficial. It will also help determine the area where primary and secondary damage is located. The close tolerance that unibody cars are built to makes it necessary to measure often from control points and monitor these measurements during repair to insure accuracy.

The accuracy or tolerance that we make reference to on all unitized cars are from end-to-end and to be the amount of three millimeters (approximately one-eighth of an inch), or the thickness of three dimes. This is achieved by the assembly of the vehicles on fixtures at the location points underneath the car when the car is assembled at the manufacturing or assembling point. Note the same year model and make of vehicle that are assembled at different geographical locations will sometimes vary in its control point measurements.

It is necessary for the technician to be sure the damaged vehicle and the undamaged one are both built in the same assembly plants. Although these measurements will be close to tolerance, they will not always be the same; and with the close precision that we must prepare these vehicles, it could be conceivable that you could take measurements that would be out of configuration and would not result in a properly repaired vehicle. There will be occasions when factory specifications published by different sources will also vary. Check, recheck, measure, and remeasure is always necessary to repair the damage.

In order to make correct measurements, to estimate or repair a unitized vehicle, it may become necessary to remove certain suspension or power train components. The front end of the unitized vehicle must be held to a minimum tolerance of less than three millimeters; otherwise, the structural and cosmetic panels will not align properly.

The suspension components on most vehicles are attached directly to the structure, particularly in the upper end of

the Macpherson's Strut. The lower control arms and sway bars attached directly to the structure are to a power train cradle assembly that is bolted to the structural panels. The rack and pinion steering on most vehicles secure to the structural cowl panel directly. In order to insure structural and cosmetic panel alignment is correct, there are seven locations on the front portion of the car that must measure accurately and be repaired to accuracy in order to insure proper repair.

They are as follows:

1. The rack and pinion steering mounting bracket located on the cowl or on a cradle assembly bracket.

2 & 3. The upper Macpherson Strut towers right and left.

4 & 5. The lower control arm mounting brackets, right and left.

6 & 7. The brake reactor rod bracket, sway bar bracket or strut rod bracket or a forward A arm bracket depending on the make and model of the car.

These features must always be in correct alignment. These lower assemblies will vary between different manufacturers, depending on what it is, the standard or modified strut. This type of suspension will not have camber and caster correction particularly on many models but, if the structural points are correct in the unibody and the components of the steering system are straight, setting of the toe in is all that is necessary in most cases to insure correct alignment and owners satisfactions.

All locations must be in correct dimensions. Over half of the collision damage occurs on the front end of the vehicle body structure. Therefore, correct measurements are essential for both analyzing and for repair. In order to measure damage, we must start measurements from an undamaged part of the car, and have at least three points with one being diagonal. Always measure in reverse sequence of the collision impact.

The one measuring tool used with all three of the measuring systems that we discussed is a steel tape. The steel tape can make cross reference measurements, it can make many length measurements, it can make diagonal measurements as long as it is an unobstructed point-to-point measurement. In other words,

most of the components underneath the car might have to be removed in order to make tape measurement. The tape measure will be used in conjunction with the Tram and centering gauge, it will be used in conjunction with the universal measuring systems, the diagnostic measuring accessory also including the laser beam unit, and it will also be unitized with the dedicated bench system.

THE DATUM GAUGE

The datum gauge is also known in some cases only as a self-centering gauge. These gauges can be obtained that will not be self-centering, but the centering distance can be set side-to-side in order to make a measurement in the area of damage on a nonsymmetrically built car. These gauges hang from reference points on the frame or body and sometimes must be attached through the use of C clamps, or through the assembly of magnets attached to the car at a correct measuring point, or over lips, or in holes put in the car by the manufacturer. The centering gauges will not make length measurements.

The Tram gauge normally utilized along with the centering gauges are what we make our length measurements with. We can utilize them to make diagonal measurements also. We can utilize them to use them for datum line measurements when they are properly set. The Tram gauges are also used when we want to measure the track of a vehicle to insure that the wheels will run straight with the vehicle frame, both front and rear.

Track of a vehicle suspension can be defined as an imaginary line through the exact center of a vehicle from end to end with all four wheels in a perfect square from it, or each wheel is located on a lateral line parallel to the center line of the vehicle, the right and left side on a square with equal length and diagonal measurements between wheels.

The self-centering gauges or the center gauge type that you can set for a center line measurement can often times be left on the vehicle while repairs are being made. They can be used to monitor the degree of correction necessary to bring a vehicle structure back into proper alignment. The jounce rebound checks that we make on vehicles as described in the tape presentation of this module are often necessary in order to determine if there is damage to the component parts of the front end suspension.

As long as there is no operator error, these measurements can be achieved with little time and they can become a major factor when you become acquainted with the measuring checks of a vehicle. They are accurate to the degree that they will tell you upon your initial measurement if it will be necessary to replace parts components on the front end suspension. Perform these checks in the sequence and in the same manner as referred to in the tape presentation of this module.

There are several universal measuring systems on the market today. In order to become familiar with them, it would be advisable to obtain the working format put out by the manufacturers on the suggested procedure routine used on their particular unit. In order to acquaint yourself with the proper use of this equipment, select the proper specification sheets necessary in order to make measurements.

Operator error is one of the biggest mistakes that are made whether it be with a measuring system of the universal type, that being of the mechanical, or that of the laser beam. It is necessary that this machinery be used as a precise measuring equipment, and it be maintained in such a manner that it does not become bent. Because if this is done to the measuring system, it is often necessary that it has to be returned to the factory for recalibration, thus taking up time and expense on the part of the repair shop or the technician. The laser beam system is one that can be attached to the vehicle or attached to a rack on which the vehicle sets and monitoring of measurements can be made completely around the car by operator observation.

THE DEDICATED BENCH SYSTEM

The dedicated bench system is one that can be used for measuring and repair. They are left on the rack and damage is straightened when they are in place. They can also be used and utilized as a holding point when repair is made on one portion or one panel of the vehicle. It can be held in place and a subsequent pull can be made forward or to the point of impact. Regardless of any of the measuring systems that we might look at, when they are properly utilized they must reveal all types of extortion.

It must be universal in performance on all vehicles. It must be quick to set up, read, and monitor. It must be appliable during repair work without preventing or complicating the straightening operation. It should be possible for one person to operate. It must be a sturdy structure but without heavy lifting devices on it. The technician must measure and cross check for accuracy and the technician must be able to raise a car in order to have full view of all damage.

Advantages of Tram Gauge

1. Minimum of investment required
2. Can be used for 3 point datum measurement
3. Can be used for checking track of vehicle
4. Can be used for length, width and diagonal comparison measurement

Disadvantages of Tram Gauge

1. Impossible to determine torsional damage and displacement
2. Deviations can only be documented with the help of dimensioned drawing or brand new cars of the same model
3. Difficult for one person to operate with extreme accuracy

Advantages of Centering Gauges

1. Easy to learn
2. Minimum investment
3. Quick to use when checking for distortion
4. May be left in place during repair
5. Check center line. Sag twist and sidesway comparison

Disadvantages of Centering Gauges

1. Deviations cannot be read in millimeters
2. Difficult to use on vehicle of non-symmetrical design
3. Must be set to datum line in order to determine accurate checks
4. Must have tram gauge to make length, width, or diagonal measurements

Advantages of Universal Systems (Mechanical)

1. Can reveal all forms of distortion
2. All defects can be read off in millimeters
3. Can be set up by one person
4. Can be read by walking around car
5. Can check all control points at the same time

Disadvantages of Universal Systems (Mechanical)

1. Fitted or located under the car and can hinder repair operation
2. Must have some type of rack for it and car to be on
3. Vulnerable to welding splatter dust and dirt dislodged during repair
4. Time consuming to remove and replace if several straightening sequences are performed
5. In case of damage, the entire unit must be returned to the factory to be recalibrated
6. Does not have a way to measure for track or alignment

Advantages of Universal System (Laser)

1. Can reveal all forms of measurement deviations
2. Can provide exact picture of deviations in the car from stated measurements
3. Is universal
4. Can be used before, during and after repair work
5. Measurement can be carried out quickly during repair work without hindering repair alignment work
6. Can measure center line
7. Can measure datum plane
8. Can measure alignment, front and rear wheel
9. Can measure track
10. Can measure cosmetic panel or structure alignment
11. One person operation

Disadvantages of Universal System (Laser)

1. Appears to be complicated unless sufficient instruction is given
2. Continuous monitoring of control point measuring scales is necessary
3. Scales or targets must be optically perfect
4. Will not measure datum distance
5. Will not measure length or diagonal
6. It is tedious to calibrate
7. Lightweight bars are easily bent
8. Unit is only as accurate as scales or target
9. Operator error is prevalent unless operator is well instructed
10. Initial cost is high
11. Takes up a lot of work area around car

Advantages of Dedicated Fixture System

1. Measurement is made with tower assembly located at factory jig fixture location
2. Measure in exact sequence and location as car was assembled
3. Towers can be installed and left in place during repair
4. Location points or posts can be dropped down during pulling operation
5. Measure from all control points that car was assembled to
6. Measures upper structure panels
7. Measures rack and pinion mounting locations
8. Measures suspension components locations to insure correct alignment of sheet metal and front end alignment except toe-in
9. Acts as jig fixture to replace new panels in correct location
10. Can be used to hold undamaged area in correct location during repair of adjacent panels
11. Can be moved to convenient location in shop area after pulling operation
12. Bench can be used with universal measuring systems, both mechanical and laser types
13. Can carry out measurement before, during and after repair
14. Can be set up and operated by one person
15. System holds the car firmly during measuring and repair operation

Disadvantages of Dedicated Fixture System

1. Are only adaptable to unibody construction
2. Some units are not high enough from floor to work under
3. Towers must be rented or bought for each model family of cars
4. Takes up shop space when not in use
5. Takes some extra lifting devices to put car on bench
6. Does not have system for rear wheel alignment
7. Pulling or repair must be done by use of pulling devices set in shop floor or fixtures that are attached to the bench
8. Towers must be of the same manufacturer as the bench that they are to be used on
9. Shortage of tower assemblies could delay repair operations
10. Towers that are not checked for accuracy of calibration after each use could result in misalignment on the next car they are used on

All three measuring systems must use factory specification sheets or an undamaged vehicle of same year and model for comparison checks.

STUDENT EVALUATION

MEASURING & FIXTURING TECHNIQUES

1. Explain the structural design of a unibody car.

2. Where are control points located on a vehicle?

3. What does performance quick checks of jounce and rebound tell us on a vehicle check?

4. What is the average weight of the vehicle of the 1980's. Circle one.
   a. 2000 pounds
   b. 2700 pounds
   c. 3500 pounds

5. What is the primary use of high-strength, high-strength-low-alloy steel?

6. How many different measuring systems do we have on the market today? Write a brief description of each of them.

7. Unitized bodies must be built to extremely close tolerance, How is this accomplished?

8. Why must the whole car be checked, even though the external damage is limited only to one area?

9. How do car manufacturers get by without using thicker materials in some areas where greater strength is needed?

10. List the four critical elements in unibody measuring and repair.

11. Which measuring system also serves as a holding system for accurate replacement of structural parts?

12. Is the control points on all vehicles used as a measuring location point for all three measuring systems?

    Circle: T or F

13. Is a dedicated bench system practical for measuring a frame and body cars?

14. To establish a datum plain using a bench system, at least how many control points on the vehicle must be located.

15. We have two types of damage that we think of in unitized repair. What are they?

    1.

    2.

16. What type of suspension, by name, is used on the front of unitized construction cars?

17. McPherson Strut towers are located on the underneath of the car at both the front and rear.

    Circle: T or F

18. Does front structure alignment affect front end alignment angles?

    Circle: T or F

19. List the sequence in which repairs of collision damage should occur?

20. Mash damage affects what measurement?

21. Sag damage affects what measurement?

22. Side sway damage affects what measurement?

23. Twist damage is present when one corner of the center section of the frame is higher than the adjacent corner.

    Circle: T or F

24. Primary damage during a collision is at what location?

25. Indirect damage is always present on any extensive collision damaged vehicle.

    Circle: T or F